


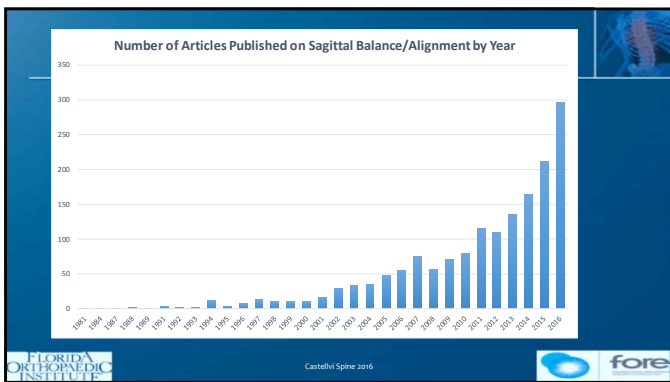


Sagittal Balance

What is It and How Did We Get Here?

Steven J. Tresser, MD
Tampa, FL








Sagittal Balance

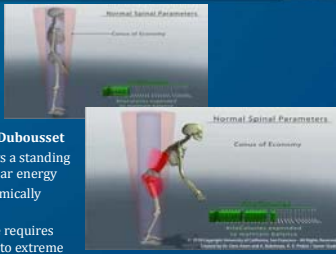
Concept:


State of spine curvature in sagittal plane which supports equilibrium (force balance)
- efficient stability.



Spinal Balance


- ❖ **Optimal Spinal Balance**
 - ❖ Head over feet
 - ❖ Shoulders over feet
 - ❖ Pelvis over feet
- ❖ **"Cone of Economy" by Jean Dubousset**
 - ❖ Ideal spinal alignment allows a standing posture with minimal muscular energy
 - ❖ Center of the cone is ergonomically favorable
 - ❖ Outside the edge of the cone requires greater energy use and leads to extreme muscular demand



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THE ROAD TO UNDERSTANDING SAGITTAL BALANCE


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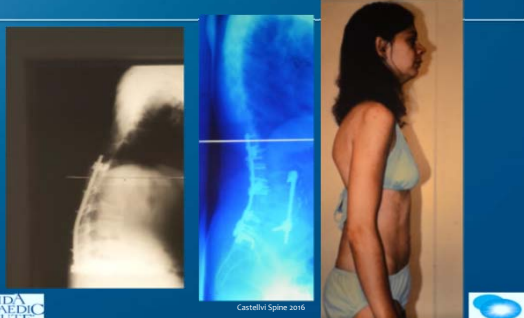
Recognition of Flat Back Syndrome 1980's

Sagittal Malalignment



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Early 1980's A-P osteotomies



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Road to Proper Sagittal Alignment was Foggy




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The Pelvic Vertebrae



Le Bassin

os intercalaire

The Pelvis is the Base of the Spine

Jean Dubousset - 1984


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Pelvic Incidence

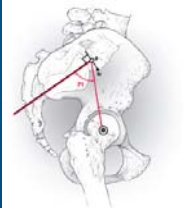
- ✦ Duval-Beaupere(1992)
- ✦ Legaye(1998)
- ✦ Definition
 - ✦ Angle between the perpendicular at the midpoint of the sacral plate and the line connecting this point to the femoral head axis
 - ✦ Everyone's pelvis is different. PI determines relationship to rest of spine



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Pelvic Incidence


- A morphological parameter
- Stays constant throughout adult life
- Not affected by patient position
- Rocking your pelvis backwards doesn't change it



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Lumbar Lordosis

- ✦ Normal lumbar lordosis is within the range of $63^\circ \pm 15^\circ$
- ✦ Relates to pelvic incidence
 - ✦ $PI - LL = +/- 9^\circ$
- ✦ At least 2/3 of LL is at L4-S1



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So What is The Connection to Lordosis?

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Normal Sagittal Alignment

Pelvic Incidence and Lordosis

Large PI

Horizontal sacrum
Marked, long lordosis

Small PI

Vertical sacrum
Flat lordosis

Pragmatic Estimate:
LL = PI +/- 10°

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Pelvic Tilt

- ❖ Angle between the vertical and line drawn from mid-sacral endplate to femoral heads
- ❖ Normal pelvic tilt is **less than 20 degrees**
- ❖ Compensatory mechanism to reduce positive balance

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Compensation for Loss of Sagittal Balance

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Pelvic Parameters

SO WHAT??

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Spine Deformity

Radiographical Spinopelvic Parameters and Disability in the Setting of Adult Spinal Deformity

A Prospective Multicenter Analysis

Frank J. Schwab, MD¹, Benjamin G. Dettori, MD², Shun-Bin Lee, MD³, Richard E. DeLuca, MD⁴, Christopher J. Shaffer, MD⁵, Justin S. Smith, MD, PhD⁶, Christian B. Esposito-Angel, MD⁷, Douglas C. Butler, MD⁸, Richard A. Anderson, MD⁹, Gregory M. Janssen, MD¹⁰, Christopher P. Ames, MD¹¹, Khalid Alshami, MD¹², Robert A. Stein, MD¹³, Jean-Françoisarcy, MD¹⁴, Virginia Latta, PhD¹⁵, and the International Spine Study Group (ISSG)

Multi-linear models

- ODI = 0.2106 * PT + 13.719
- ODI = 1.5563 * SVA - 16.293
- ODI = 0.4379 * PI - LL - 6.0827

Thresholds for Disability (ODI > 40)

- PI - LL > 11°
- SVA > 47mm
- PT > 20°

PI minus LL

- 0 : within 10°
- + : moderate 10-20°
- + + : marked > 20°

Global alignment

- 0 : SVA < 4cm
- + : SVA 4 to 9.5cm
- + + : SVA > 9.5cm

Pelvic Tilt

- 0 : PT < 20°
- + : PT 20-30°
- + + : PT > 30°

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Alignment Matters

Figure 3. Deterioration in CDE scores was noted in the region of greatest highest progression from high thoracic to lumbar spine.

Loss of lumbar lordosis is especially poorly tolerated and has direct effect on disability

Glassman SD, Bridwell K, Dimar JR, et al. The impact of positive sagittal balance in adult spinal deformity. *Spine* 2005;30:2024-9.

Alignment Matters

- Preservation/restoration of lumbar lordosis is crucial to the success (*clinical outcome: pain/disability*) of any lumbar fusion.
- Sagittal balance is directly correlated to clinical outcome: avoid sagittal decompensation.^{1,2}
- If the clinically relevant radiographic parameters are not achieved the patient runs a **10x** higher risk of reoperation.²

RELEASED

¹Mehta VA, Amin A, Omeis I, et al. Implications of spinopelvic alignment for the spine surgeon. *Neurosurgery* 2012;70:707-21.
²Rothenfluh DA, Mueller DA, Rothenfluh E, et al. Pelvic incidence-lumbar lordosis mismatch predisposes to adjacent segment disease after lumbar spinal fusion. *Eur Spine J* 2015;24(6):1211-8.

Impact of Sagittal Balance


- Adverse health outcomes are highly correlated with positive sagittal balance
- Sagittal balance assessment should be a critical consideration during patient evaluation and surgical planning



Figure 3. Deterioration in health status measures, including SF-12 health status measure scores (A) and EQ-5D (B), were observed in asymptomatic patients with positive sagittal balance.

Goals for Patient Outcomes

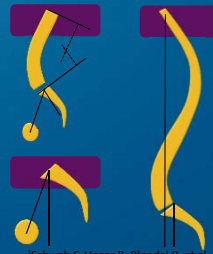
Sagittal Balance Restoration
aims to improve patient quality of life:

- ✦ Resolve Pain and dysfunction
- ✦ Restore horizontal gaze
 - ✦ Ability to make eye contact
- ✦ Provide energy conservation
 - ✦ Movement requires less muscle engagement and fatigue
- ✦ Arrest evolution of deformity



Goals for Sagittal Balance



Alignment Objectives¹

1. $PI - LL < 10^\circ$
2. $PT < 20^\circ$
3. $SVA < 5cm$

¹Schwab F, Ungar B, Blondel B, et al. Scoliosis Research Society - Schwab adult spinal deformity classification. A validation study. *Spine* 2012;37(12):1077-82.

